DECEMBER 2012
QUARTERLY GROUNDWATER MONITORING REPORT

VULCAN-LOUISVILLE SMELTING SITE
NORTH CHICAGO, LAKE COUNTY, ILLINOIS

Prepared for:

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LIST OF ACRONYMS AND ABBREVIATIONS

DCE	Dichloroethene
EE/CA	Engineering Evaluation/ Cost Analysis
HASP	Health and Safety Plan
NA	Natural Attenuation
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
START	Superfund Technical Assessment and Response Team
OTIE	Oneida Total Integrated Enterprises
PCBs	Polychlorinated Biphenyls
TCE	Trichloroethylene
TDD	Technical Direction Document
TOC	Total Organic Carbon
U.S. EPA	U.S. Environmental Protection Agency
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

The U.S. Environmental Protection Agency (U.S. EPA) has tasked Oneida Total Integrated Enterprises (OTIE) with the evaluation of the natural attenuation (NA) process in the groundwater plume at the Vulcan Louisville Smelting (Site) located in North Chicago, Illinois. OTIE was tasked to collect groundwater samples from existing monitoring wells, analyze the results, evaluate contaminants and daughter product concentrations, and determine the specifics of any natural attenuation, if prevalent at the Site. This work was performed under U.S. EPA Contract Number (No.) EP-S5-10-10 and Technical Direction Document (TDD) No. TO-02-12-06-1002.

This report describes the sampling and analysis activities and sampling results associated with the groundwater monitoring wells at the Site.

2.0 SITE DESCRIPTION AND BACKGROUND

The Site is located at 1 Tantalum Place in North Chicago, Lake County, Illinois and is comprised of two parcels; the former Fansteel parcel to the east and the Vacant Lot parcel to the west of the Fansteel parcel. The Vacant Lot was originally bisected by Pettibone Creek (Creek), an intermittent stream. The Creek has been re-routed to allow for the development of the Vacant Lot. A map of the project area showing the monitoring well network is presented in Figure 1. The Fansteel Engineering Evaluation/ Cost Analysis (EE/CA) investigation completed in 2005 by Penn Environmental & Remediation, Inc. identified elevated levels of cadmium, lead, trichloroethylene (TCE), tetrachloroethylene, also known as perchloroethylene (PCE), and vinyl chloride (VC) in soils and elevated levels of lead, cadmium, TCE, VC, and other volatile organic compounds (VOCs) in groundwater on the Fansteel property.

Past use and practices at the Vulcan Louisville Fansteel Site resulted in the contamination of the subsurface soils and shallow aquifer with PCE and TCE, in addition to other contaminants including lead and polychlorinated biphenyls (PCBs). Site groundwater flows in a southwesterly direction from the contaminant sources in the Fansteel parcel towards Vacant Lot and then towards Pettibone Creek. The U.S. EPA conducted a removal action on both parcels in November and December 2008 to mitigate the release of hazardous substances and to abate threats to human health and the environment. The U.S. EPA removal efforts have included soil excavation up to 15 feet below ground surface (bgs) in the Fansteel area and up to 6 feet bgs in the Vacant Lot area and disposal of TCE-contaminated soil in an U.S. EPA approved landfill. Post-excavation samples were collected from the excavation floor in both areas to document the soil contamination remaining at the Site after completion of the removal action. Deeper soils with residual contamination exist in both areas and were not excavated because of groundwater infiltration issues. Removal activities were completed at the Site in December 2008. The removal areas are shown in Figure 1. The City of North Chicago has acquired the Fansteel parcel and a portion of the Vacant Lot parcel east of Pettibone Creek in order to foster redevelopment of the Site.

In order to address the TCE groundwater plumes existing in Fansteel and Vacant Lot areas, a quarterly groundwater monitoring program was initiated in the summer of 2010. Groundwater

Insert Figure 1

sampling has been conducted in June 2010, October 2010, May 2011, August 2012, and December 2012. The goal of the quarterly groundwater monitoring program is to assess whether NA is occurring at the Site and the role of NA in the eventual degradation of the contaminants of concern in the groundwater.

The NA processes include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants. The commonly accepted, dominant process in NA has been the biologically-mediated sequential reductive dechlorination. The anaerobic reductive dechlorination involves the sequential removal of chlorine atoms and their replacement with hydrogen atoms by anaerobic bacteria. Sulfate-reducing bacteria and other anaerobes can reductively dechlorinate PCE and TCE to cis-dichlorothene (cis-DCE). However, only the unique bacterium *D. ethenogenes* can dechlorinate cis-DCE sequentially to VC and then completely to ethylene.

3.0 SITE PREPARATION

Prior to December 11-12, 2012 quarterly groundwater sampling activities, OTIE performed the following tasks:

- scheduled personnel and vehicles;
- arranged access to property with the City of North Chicago consultant; and
- secured field equipment for sampling.

The overall objective of quarterly sampling is to monitor post-removal groundwater quality and ascertain NA of the groundwater plume.

4.1 Water Level Measurements

Water levels were measured in the monitoring wells prior to field water quality measurement or sampling activities using a Solinst® water level indicator. Water level measurements were taken from eight monitoring wells to establish Site-specific groundwater levels. VLF-MW-1 (MW-1) was dry and therefore no water level data could be collected. Water level measurements varied between 9.8 feet below ground surface (bgs) at VLF-MW-6 (MW-6), the westernmost source well on the Vacant Lot adjacent to Pettibone Creek, and 13.5 feet bgs at OLD-MW-9, the southernmost well located between the Fansteel parcel and the Vacant Lot.

VLF-MW-2 (MW-2) is the source well for the Fansteel parcel. MW-1 is an upgradient well, and VLF-MW-3 (MW-3) and VLF-MW-4 (MW-4) are both down-gradient wells for the Fansteel parcel. MW-6 is the source well for the Vacant Lot, while VLF-MW-5 is the upgradient well and VLF-MW-7 is the down-gradient well. OLD-MW-9 and OLD-MW-4 wells sit between the Fansteel parcel and the Vacant Lot.

4.2 Groundwater Sampling

Groundwater samples were collected from the source areas of Fansteel and Vacant lot, and from the down-gradient, upgradient and cross gradient wells following low-flow sampling method (EPA, 1996).

4.2.1 Purging and Sampling of Monitoring Wells

Low-flow pumping rates in the approximate range of 0.1 to 0.3 liters per minute (L/min) were used for purging all monitoring wells prior to collecting groundwater samples. Purged groundwater was directed through the Horiba U22®, a flow-through-cell equipped with a multi-parameter probe. Purging was continued until water quality parameters had stabilized

as described in Table 4-1. Temperature, pH, specific conductance, oxygen reduction potential (ORP), dissolved oxygen (DO), and turbidity were recorded at 5 minute intervals during purging until parameters had stabilized. Parameters were considered "stabilized" when three consecutive readings within the criteria listed in Table 4-1 were recorded. MW-1 was dry on both sampling days and therefore no samples were able to be collected from this location. In three instances, monitoring wells, MW-2, MW-7, and OLD-MW-9, dried out during purging prior to reaching stabilization. As a result, samples were collected as soon as the appropriate volume of water was recharged within the well regardless of parameter stabilization as per the EPA low-flow sampling method (EPA, 1996).

After field parameters had stabilized for those wells that did not dry up, samples were collected into the appropriate containers. VOC samples were collected first, followed by metals and NA parameter samples. All metal samples were filtered before collection with a 0.45 micron filter.

Table 4-1
Groundwater Parameter Stabilization Criteria
August 2012 Quarterly Groundwater Monitoring
Vulcan-Louisville Smelting Site

Measurement	Criteria
pH	± 0.1 pH unit
Temperature	± 10 percent
Conductivity	± 3 percent
ORP	± 10 millivolts (mV)
Dissolved oxygen	± 10 percent
Turbidity	Target of 10 NTUs or less for metals samples, 50 NTUs or less for organics samples

4.2.2 Sample Collection Order Used

1. VOCs
2. Metals
3. alkalinity, ethane, ethylene, chloride, nitrite, nitrate, dissolved methane, sulfate, and total organic carbon (TOC)

4.2.3 Sample Analysis

A total of eight wells (OLD-MW-4, OLD-MW-9, and MW-2 through MW-7) were sampled as part of this monitoring program. All samples were collected and analyzed for VOCs, metals and NA parameters using SW-846 methods and other EPA-approved methods. All samples were sent to TestAmerica Laboratories located in University Park, Illinois for analysis requiring a normal turnaround time of 15-days for reporting the results. OTIE validated analytical data provided by reports received from TestAmerica (Appendix B). The number of samples collected, analytical methods used and analytical results are included in Tables 5-1 and 5-2. It should be noted that nitrates and nitrites were analyzed outside of acceptable holding time for MW-2 and MW-5. These samples were flagged as 'UJ' which denotes that the analytes were estimated as undetected.

4.2.4 Disposal of Purged Water

All purged groundwater was containerized in a 55-gallon drum and is currently stored at the Site for disposal. As groundwater sampling activities have been completed, the drum is awaiting disposal by Clean Harbors Environmental Services (CHES). Based on the analytical results, the purged water will be disposed of as required following applicable regulations. The groundwater will be transported and disposed of by CHES at their facility in Cleveland, Ohio.

5.0 ANALYTICAL RESULTS & CONCLUSIONS

A total of eight wells were sampled during the August 2012 quarterly groundwater monitoring event at Vulcan Louisville Smelting Site. Groundwater samples were collected from wells around the two areas where source removal was conducted in 2008 and from wells along the property line between Fansteel and Vacant Lot. Sample analytical results and water quality measurements are summarized and shown in Table 5-1 and Table 5-2, respectively.

Fansteel Area

Monitoring well MW-2 is the source area well for the Fansteel area groundwater plume. In previous sampling events, high concentrations of TCE and its daughter compounds, cis- and trans-1, 2-DCE and VC were found in the source well. Analytical results from the August 2012 sampling event demonstrate a significant decrease in TCE, DCE, and VC concentrations in the Fansteel source area well MW-2. Further, the December 2012 analytical results demonstrate continued non-detect concentrations of DCE and VC for monitoring well MW-2. The most significant decrease in MW-2 well was demonstrated in TCE concentration which decreased from 4,400 micrograms per liter (µg/L) in May 2011 to 0.50 µg/L in August 2012. DCE and VC were non-detect in MW-2 well during the August 2012 and December 2012 sampling events. Down-gradient well from the Fansteel source area, MW-3, demonstrated significant increases in TCE, DCE, and VC concentrations in both August and December 2012. The most significant increase in monitoring well MW-3 was demonstrated in TCE concentration which increased from 180 µg/L in May 2011, to 6,000 µg/L in August 2012 and 20,000 µg/L in December 2012. The concentrations of cis-1, 2-DCE in monitoring well MW-3 increased from 200 µg/L in May 2011, to 3,400 µg/L in August 2012 and 15,000 µg/L in December 2012, while the concentrations of trans-1, 2-DCE only showed a slight increase from 51 µg/L in August 2012 to 220 µg/L in December 2012. In monitoring well MW-4, cis-1, 2-DCE concentrations increased from 90 µg/L in May 2011 to 670 µg/L in August 2012 and then decreased to 50 µg/L in December 2012. An increase in trans-1, 2-DCE was also observed in monitoring well MW-4, from 1.8 µg/L in May 2011 to 19 µg/L in August 2012, but a decrease was observed to 1.5 µg/L in December 2012. The VC concentration increased in monitoring well MW-4 from 27µg/L in May 2011, to 43 µg/L in August 2012 and decreased again in December 2012 to 20 µg/L. Higher

concentrations of cis-1, 2-DCE compared to trans-1, 2-DCE in Fansteel monitoring well MW-3 indicates degradation by microbial activity. Additionally, the significant increases of TCE, DCE, and VC concentrations in the down-gradient well may suggest that the plume has migrated; however, increased concentrations in both DCE and VC in monitoring well MW-3 indicate that reductive dechlorination is occurring in the Fansteel area. There was also a slight increase in ethylene concentrations in the down-gradient monitoring well MW-3, which is the ultimate desired product of reductive dechlorination.

Mercury was detected in monitoring wells MW-2, MW-3, MW-4, duplicate sample, MW-6A, and OLD-MW-9 during the December 2012 sampling event at levels above 0.002 mg/L, the Maximum Contaminant Level (MCL) for mercury in drinking water as per the National Primary Drinking Water Regulations. Mercury was also detected in groundwater samples collected from MW-3 and MW-4 during the August 2012 sampling event. Lead was also detected in groundwater sample OLD-MW-9 above the MCL of 0.015 mg/L.

Anaerobic conditions exist at the down-gradient wells MW-3 and MW-4. MW-4 has exhibited strictly anaerobic conditions. DCE and VC are assumed to be formed by reductive dechlorination under anaerobic conditions, whereas some of the wells are aerobic, having positive ORPs in the Fansteel Area. It is possible that current aerobic areas are the result of depletion of native electron donors. Aerobic processes that may be contributing to natural attenuation are co-metabolic aerobic degradation of low concentrations (< 3 mg/L of VC, DCE, and TCE) mediated by methane-using bacteria (methanotrophs) and ethylene-using bacteria (ethenotrophs). Appendix A provides quarterly monitoring report charts for all of the monitoring wells within the Fansteel Area.

Vacant Lot

Monitoring well MW-6 is the source area well for the Vacant Lot groundwater plume. In previous sampling events, high concentrations of TCE and its daughter compounds, cis- and trans-1, 2-DCE and VC were found in the source well. In the Vacant Lot area, TCE concentrations were less than its daughter compounds in the source area well, MW-6. TCE concentrations decreased in MW-6 from 550 µg/L in May 2011 to 64 µg/L in August 2012;

however, TCE concentrations increased to 170 µg/L in December 2012. There was a significant decrease in cis-1, 2-DCE from 22,000 µg/L in August 2012 to 14,000 µg/L in December 2012. Monitoring well MW-6 also demonstrated an increase in trans-1, 2-DCE from 230 µg/L in August 2012 to 280 µg/L in December 2012. The concentration of VC decreased from 6,500 µg/L in August 2012 to 4,400 µg/L in December 2012. Sustained concentrations of TCE at low levels in combination with significant increases of DCE and VC concentrations indicate that reductive dechlorination is occurring within the Vacant Lot source area. Higher concentrations of cis-1, 2-DCE compared to trans-1, 2-DCE in the source well indicates degradation by microbial activity. Ethylene concentration within the Vacant Lot area source well was also slightly higher than previous sampling results, increasing from 15 µg/L in August 2012 to 37 µg/L in December 2012. This also indicates reductive dechlorination. The analysis of groundwater samples from upgradient well MW-5 and down-gradient well MW-7 did not provide results that offered any conclusive information about the viability of NA. It should also be noted, that there were no elevated metal concentrations found in any of the wells within the Vacant Lot area of the Site during this sampling event.

Strict anaerobic conditions exist in the Vacant Lot source area well whereas aerobic conditions exist in the upgradient wells on Fansteel property. DCE and VC are formed by reductive dechlorination under anaerobic conditions within the Vacant Lot source area, while the upgradient wells are demonstrating aerobic conditions, having positive ORPs. As previously discussed, processes that may be contributing to NA are co-metabolic aerobic degradation of low concentrations of VC, DCE and TCE mediated by methanotrophs and ethenotrophs. Currently, these NA processes are only being observed within the Vacant Lot source area well. Appendix A provides quarterly monitoring report charts for all of the monitoring wells within the Vacant Lot.

Conclusion

Though it is evident that TCE has been degraded into its daughter products by microbial activity in Site groundwater, the process of natural attenuation as a viable alternative at the Site is not conclusively determined with these sampling events to-date. While reductive dechlorination is actively occurring, the existing Site conditions may not be sufficient to verify that source removal activities have contributed to natural dissipation of the groundwater plumes to

acceptable levels with regard to background levels. Additionally, the degradation rates cannot be accurately extrapolated as the plume has seemed to shift and ethylene levels have not yet increased enough to demonstrate that TCE is degrading fully. While there are no additional groundwater sampling activities scheduled at this time, a bio-stimulation/bio-augmentation pilot study may be very useful in determining the efficacy of natural attenuation, more specifically including subsurface injections of a mixture of zero-valent iron (ZVI) combined with nutrients. These injections hasten the process of natural attenuation by providing an abiotic reaction with iron that immediately reduces TCE to its daughter compounds. Additionally, the nutrients support anaerobic bacterial growth which assists in creating a reducing environment which will reduce TCE and daughter compounds to VC and ethylene. These types of mixtures have the potential to remain on Site for many years after initial injection, prolonging their effects on the rate natural attenuation.

TABLE 5-1

TABLE 5-2

APPENDIX A

Groundwater Monitoring Results Charts

APPENDIX B

Validated Analytical Data Package